Large-Area MoS_2 Thin Layers Fabricated by Sulfurization with Thermal Cracker

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Due to its unique electronic properties of indirect-to-direct band-gap transition and extremely high mobility, two-dimensional (2D) ultra-thin molybdenum disulfide (MoS_2) has been attracting increasing attention for its potentials in various high-performance electronics. However, for practical applications, fabrication of a uniform multi-layered MoS_2 layer on a large area substrate has been a challenging issue. In this work, we demonstrate a simple method to form thin MoS_2 layers by sulfurizing a Mo film in a vacuum. The sputter-deposited Mo films were sulfurized by reactive sulfur atoms produced from a thermal cracker. The number of layers of MoS_2 was controlled by varying the Mo thickness. The Raman spectroscopic and optical transmittance measurements revealed that the MoS_2 thin films were successfully formed on SiO_2/Si and soda-lime glass substrates. The Raman results of the MoS_2 films showed peak-to-peak distances, between the E^1_{2g} and A_{1g} peak positions, of under 25 cm^{-1}, indicating a successful formation of 2D MoS_2. The intensity, FWHM, and position of the Raman peaks demonstrated that the MoS_2 film was fabricated very uniformly in centimeter-scale substrates, which were obtained at several different positions. Back-gated transistors were fabricated on these MoS_2 films and their electrical properties were characterized.